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Letter
Circular
LC 221

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON

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TESTS OF RESISTANCE APPARATUS

This letter circular supplements the following Test Fee Schedules.

113. Precision Resistance Standards
114. Precision Resistance Apparatus
151. Resistance Standards for Current measurements.

Condition of Apparatus. - To be accepted for test and certification, precision resistance standards and resistance apparatus must be of good design, workmanship and material, must have clean contacts, clean and good insulation, and must be in good working condition. If it is evident that the apparatus has been kept in rancid oil, used with excessive test currents or otherwise abused, or has not received proper care, a test will be made only in case it is shown that there is a special need for it.

Precision Resistance Apparatus. - The following features are considered essential in the best precision resistance apparatus:

(a) Resistance material - The resistance material should have a low temperature coefficient, should not change its resistance with time, and for low-valued coils should have a small thermoelectromotive force against copper.

(b) Construction - All wire resistance standards and the more important sections of resistance apparatus should be wound on metal supports, preferably in a single layer. Electrical connections to the resistance material should be brazed in all cases in which the total resistance is less than 1000 ohms. The resistance material should be protected against oxidation and other chemical action, and after winding should be annealed and aged.

(c) Adjustments - Resistance standards and apparatus should be so adjusted as to give an accuracy of at least 0.1 per cent without corrections.

(d) Design - Terminals should be so arranged as to give definite values to the resistances. Provision for dissipating heat should be such that the errors caused by heating under conditions of test or use will not prevent measurements to a

precision somewhat higher than that desired in the test.

New Apparatus.- Because of the comparatively rapid changes in resistance which take place in new apparatus, it is not advisable to test new or repaired apparatus until at least two months after it has been annealed and adjusted.

Test Current.- Unless otherwise stated, the tests listed are generally made using a direct current of such magnitude as to cause only a negligible heating of the resistance material.

Nature of Test.- Unless otherwise stated, tests of resistance standards, bridges and rheostats consist in determinations of the resistance of the standards, or of the resistance of the elements of the bridges or similar apparatus corresponding to all possible readings. Tests of potentiometers and volt boxes (or potential dividers) consist in determinations of the ratios of the resistances corresponding to all possible readings.

Resistance Standards for Current Measurements.- Resistance standards used to measure large currents are often heated by the passage of the current to such an extent as to cause a material change in their resistance. Such standards when first submitted for test should be tested both with small test current and with full rated current. (Schedule 101(a) and (b) or (c)). The change in resistance between these two conditions, if not excessively large, is a fairly definite property of the standard, and in later tests, determinations need be made only with small test current (Schedule 101(a)). Standards of large current capacity are often so constructed that the temperature distribution in them is dependent to a large extent upon the heat generated at the current terminal contacts and on the cooling effects of the bus-bars to which they may be connected. When this is the case, resistance determinations made in the laboratory even with rated current cease to be of value because the working temperature conditions can not be duplicated. The best experimental procedure to use in such cases is to place the standard in a thermostat and measure its resistance when it is heated uniformly to temperatures approximating that at which it will operate in service. (Schedule 101(d)). From data at two or more elevated temperatures combined with that at room temperature a curve can be plotted from which the resistance at the actual operating temperature can be read off, provided this actual temperature is determined by the user with the standard under the actual operating condition.